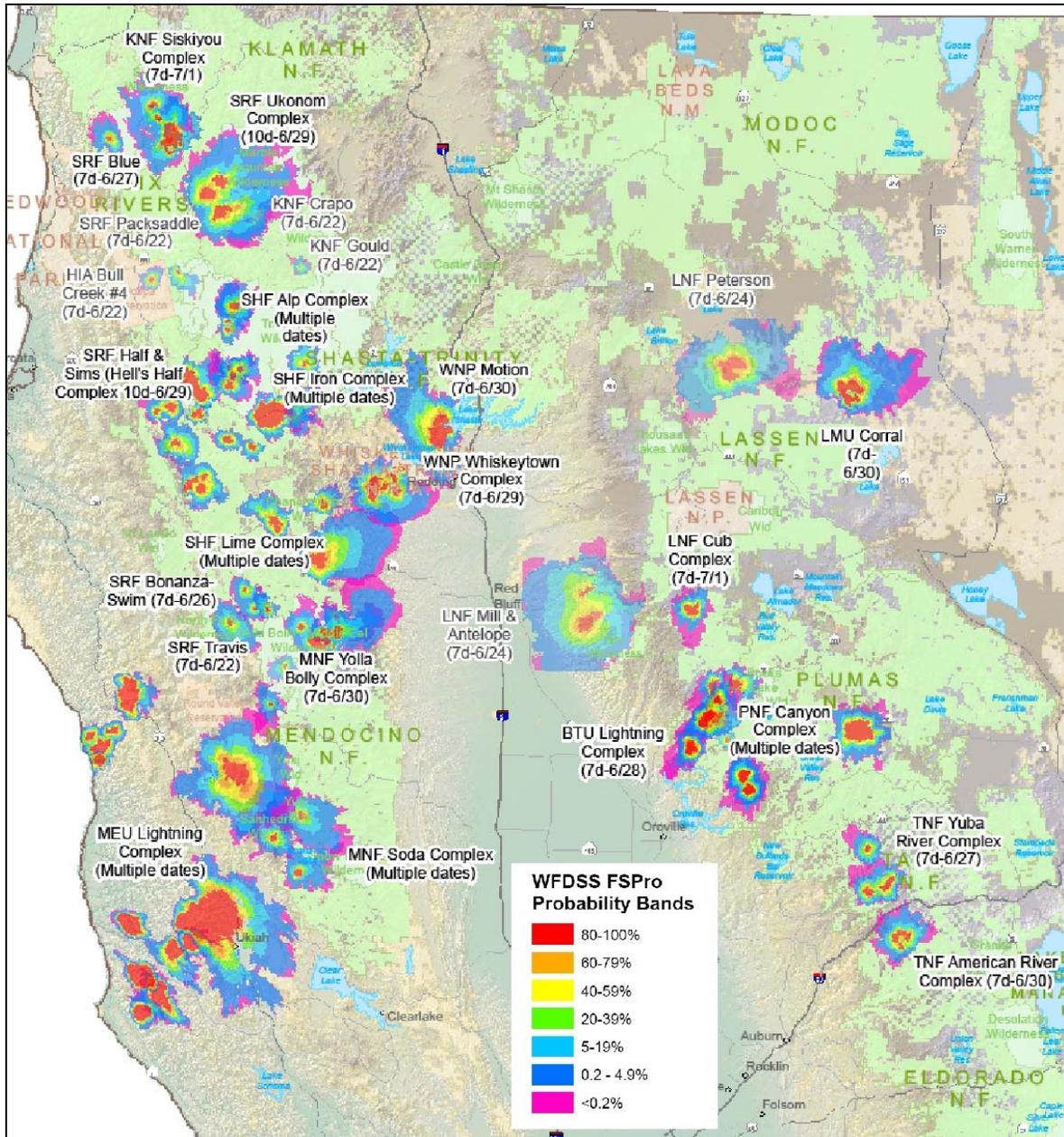


# Northern California Fire Behavior Assessment

## ONC Support 2008

Prepared 07/07/2008



## ***Introduction***

On June 21st wide spread lightning started hundreds of fires in northern California. The magnitude of ignitions outpaced initial attack capabilities of firefighting resources. Accessible fires with low resistance to suppression were easily contained while unstaffed fires in remote and difficult terrain burned freely for several days. The focus of this analysis is to look ahead into the emerging 2008 fire season and identify synoptic fire behavior issues. This information will be used by fire managers to identify broad scale values at risk and assist in resource allocation associated with temporal and spatial changes in fire behavior.

## ***Objectives***

- Provide a landscape assessment of fire behavior over the remainder of the fire season.
- Evaluate the potential weather scenarios that effect fire spread.
- Identify the relative changes in fire behavior utilizing seasonal synoptic changes in weather.
- Evaluate potential growth on fires that receive minimal staffing, or have high resistance to suppression.
- Identify temporal changes in the fire environment and how fire behavior changes as the season progresses, fuels cure and moisture decreases.
- Provide links to existing intelligence pertaining to fire weather and fire danger for northern California.

## ***Synoptic Weather and Fire Behavior***

The analysis was conducted in the context of northern California Predictive Service Areas (PSA). There are eight predictive service areas in northern California, each representing different weather and fire behavior trends (Figure 1). Most of the factors important in determining the potential for large fire growth are weather and fuels-related. The Predictive Services Group collects and analyzes information by Predictive Service Area producing many products that are useful for examining weather, climate, fire danger, and fire growth potential over the various PSAs. Table 1 describes the general characteristics of each PSA and the groups of fires burning in each.

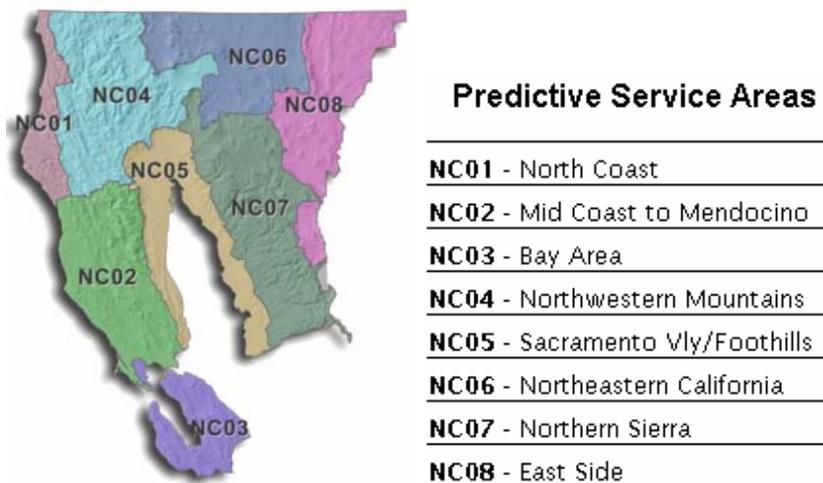


Figure 1. Northern California Predictive Service Areas

Table 1. Predictive Service Area characteristics and current fires

Predictive Service Area	Bioregion	Vegetation/Fuels		Fires
North Coast	North Coast	Coastal scrub, chaparral, grass, oak woodland, Redwood, coastal pine and spruce		MEU Lightning
Mid Coast to Mendocino	North Coast	<u>Mid-Coast</u> chaparral, coastal scrub, grass, oak woodland, Redwood, coastal pine and spruce	<u>Inland Valleys/Mountains</u> chaparral, grass, oak woodland, Redwood, mixed conifer	MEU Lightning, Soda, Yolla Bolly
Bay Area	Central Coast	Coastal scrub, chaparral, grass, oak woodland, Redwood, coastal pine, eucalyptus		
Northwestern Mountains	Klamath Mountains	Chaparral, grass, oak woodland, mixed conifer		Ukonom, Siskiyou, Alps, Iron, Lime, Mad, Hell's ½, Whiskeytown, SHU Lightning
Sacramento Valley/Foothills	Central Valley	Chaparral, grass, oak woodland		SHU Lightning
Northeastern California	Southern Cascades	Grass, Pinyon, Western Juniper, Sage, Jeffery Pine, Mixed conifer		
Northern Sierra	Sierra Nevada	Chaparral, grass, oak woodland, mixed conifer, true fir		Cub, Canyon, American, Yuba, BTU Lightning, Corral
East Side	North Eastern Plateau	Grass, Pinyon, Western Juniper, Sage, Jeffery Pine		

Weather patterns and associated fire behavior are summarized below by Predictive Service Area (PSA).

**North Coast & Bay Area**

Critical fire weather is generated by:

- Pacific High (Post frontal) and the Great Basin High pressure systems which produce warm, dry east winds which displace the marine air mass off the coast.
- Subtropical High aloft which produces abnormally high temperatures and low relative humidity.

Fire behavior implications:

- Absence of marine layer dries fuels and creates periods of high fire danger. When in concert with wind and complex terrain rapid fire growth with frequent spotting occurs. Example: 1991 Tunnel Fire, 2008 Summit Fire.

## **Mid Coast to Mendocino**

Critical fire weather is generated by:

- Pacific High (Post frontal) and the Great Basin High pressure systems which produce warm, dry east winds which displace the marine air mass off the coast.
- Subtropical High aloft which produces abnormally high temperatures and low relative humidity.
- Localized effect of deep marine layer spilling over the crest of the Mendocino Mountains and thermal low that is created by heating in the Central Valley. This condition occurs on the east side of the PSA.

Example: 1953 Rattlesnake Fire

Fire behavior implications:

- Localized effect described above causes strong down-slope wind which changes the direction and speed of fire spread.

## **Northwestern Mountains**

Critical fire weather is generated by:

- Post-frontal conditions occur when high pressure following the passage of a cold front causes strong winds from the north and northeast  
Example: 1999 Megram and Jones Fires
- Pre-frontal conditions occur when strong, southwesterly or westerly winds are generated by the dry, southern tail of a rapidly moving cold front.  
Example: 2001 Oregon Fire

- Subtropical High conditions occur when the region is under the influence of descending air from high pressure that causes temperatures to rise and humidity to drop.  
Example: 1987 Hayfork Fires, 2006 Bar Complex Fires

Fire behavior implications:

- Rollout and spotting in complex topography are key factors to fire spread. Topography also creates persistent inversions, limiting visual observation of fire behavior by ground personnel and aircraft reducing situational awareness.

## **Northeastern California & Eastside**

### *Southern Cascades*

Critical fire weather is generated by:

- Post-frontal conditions occur when high pressure following the passage of a cold front causes strong winds from the north and northeast  
Example: 2002 Cone Fire
- Pre-frontal conditions occur when strong, southwesterly or westerly winds are generated by the dry, southern tail of a rapidly moving cold front.  
Example: 1987 Lost Creek Fire, Hat Creek Valley, 1992 Fountain Fire
- Subtropical High conditions occur when the region is under the influence of descending air from high pressure that causes temperatures to rise and humidity to drop.

Fire behavior implications:

- With Subtropical High conditions, fires are affected mainly by local fuel conditions, diurnal wind flow, and topography. In areas with steep elevation gradients, shifting diurnal winds cause fires to continually change directions.

### *Northeast Plateau*

Critical fire weather is generated by:

- Pre-frontal winds from the south and southwest which can surface strongly on the east side of the lee side of the Cascade Range and Sierra Nevada. Downward moving air masses lose elevation, gain temperature and lose relative humidity.
- Lightning with low precipitation is most common in July and August, but can occur in June and September.
- Moist Monsoon pattern is rare on the Northeast Plateau, however if it does occur many wildfires can be ignited during this pattern. Accompanying precipitation limits fire ignition and spread.
- Strong subsidence/low relative humidity can increase fire potential even in the absence of wind; poor nighttime relative humidity recovery is also a primary factor. This condition is most common in August and September.

Fire behavior implications:

- Pinyon Pine, Juniper and sage brush fuels exhibit rapid rates of spread with torching, crowning, and long-range spotting, especially when influenced by low relative humidity and wind. Fire whirls are a common fire behavior feature in this area.

Example: 2007 Fletcher Fire, Modoc NF

### **Northern Sierra**

Critical fire weather is generated by:

- Post-frontal conditions occur when high pressure following the passage of a cold front causes strong winds from the north and northeast.
- Great Basin High condition creates strong pressure gradients and easterly and northeasterly winds across the Sierra.  
Example: 2007 Wheeler Fire
- Subtropical High condition displaces westerly winds to the north and stagnate air blocks moist air from the Gulf of Mexico bringing high temperatures and low relative humidity.
- Meridional Ridge with a southwest flow allows marine air to penetrate coastal and inland areas. Above the marine layer in the Sierra Nevada, temperatures are higher and relative humidity is lower as short wave troughs and dry frontal systems pass over the area.

Fire behavior implications:

- Low humidity accompanied by high wind allows fires to spread rapidly through timber, transitioning from torching to active crown fire with long-range spotting.

### **Sacramento Valley/Foothills**

Critical fire weather is generated by:

- Winds created by the Great Basin High and Pacific Low trough come from the north and with considerable strength.
- Thermal belts are created above the dense pool of cool air that settles in the valley. Fires burn freely above this layer in dry fuels, lower relative humidity and warmer temperatures.

Example: 1976 Skinner Mill Fire

Fire behavior implications:

- Fires are wind-driven, with rapid rates of spread in dry, flashy fuels.

Table 2. Historical Fires of Interest, Northern California

Fire	Year	Location	Acres	PSA	Notes
Megram	August 23, 1999	Six River NF	124,898	Northwest Mountains	Blow-down timber, wind driven run in the fall, 70+ days to contain
Hog	August 10, 1977	Klamath NF	46,530	Northwest Mountains	24 days to contain
Trough	August 8, 2004	Mendocino NF	25,000	Mid Coast to Mendocino	Chaparral and timber
Canoe	September 3, 2004	Humboldt Redwoods SP	13,744	North Coast	Coast Redwood 30+ days to contain
Rattlesnake	July 9, 1953	Mendocino NF	1,300	Mid Coast to Mendocino	Chaparral, localized wind, fatality fire
Vision	October 3, 1995	Point Reyes NP	12,000	Mid Coast to Mendocino	Bishop Pine/Doug fir Coastal Sage, wind driven
Crank	August 30, 1987	Modoc NF	4076	Northeastern California	Timber, T-storm winds, shelter deployment
Star	August 25, 2001	Tahoe NF	16,600	Northern Sierra	Timber, 18 days to contain
Moonlight	September 3, 2007	Plumas NF	65,000	Northern Sierra	Timber, plume dominated & wind driven 22 days to contain
Tunnel	October 20, 1991	Oakland Hills	1,520	Bay Area	Interface, wind driven, fatality fire
Skinner Mill	June 27, 1976	Mendocino NF	89,130	Sacramento Valley/Foothills	Wind driven

## ***Fire Behavior Analysis***

Tools used in this analysis include FlamMap (ver. 3.0.0.1), weather and fire analysis in Fire Family Plus (ver. 3.0.5), Rare Event Risk Assessment Process (RERAP, ver 7.03), and Fire Spread Probability (FSPro, Beta version 2008). Other data sources used for the analysis include the U.S. Drought Monitor, the National Climatic Data Center, Western Regional Climate Center, and data from Northern California Geographic Area Coordination Center Predictive Services.

The best available information was applied to the models used in this analysis. Fire behavior prediction tools are based on modeled fuels and weather assumptions which may not represent the actual conditions. Actual weather and wind can differ significantly from modeled inputs based on forecasts or scenarios. The FlamMap tool assumes constant wind conditions across the landscape and does not account for spotting, rollout, or suppression actions. FSPro uses climatological probabilities based on historical data that may not adequately capture occurrence of extreme burning conditions.

## **General**

Fire behavior characteristics were modeled under three conditions – inversions, large fire growth, and extreme. Adjustments were made to fuel moisture and wind speed inputs to represent the varying burning conditions. The landscapes used for modeling are intended to be samples of areas that might represent a particular PSA. Three PSAs were modeled – Northwestern Mountains, Mid Coast to Mendocino and Northern Sierra. These PSAs all contain incidents that

have the potential to be long duration and differ in fuel characteristics, topography and climate enough to warrant comparison analysis.

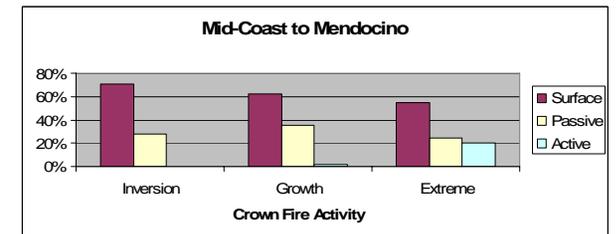
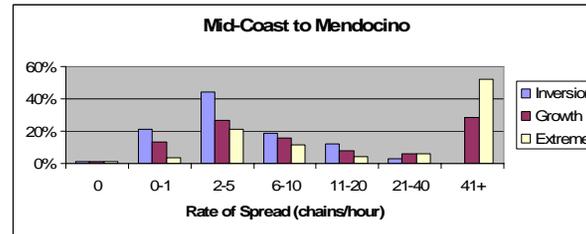
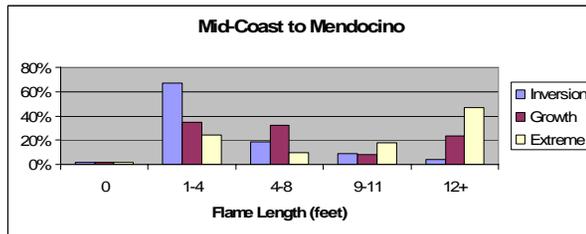
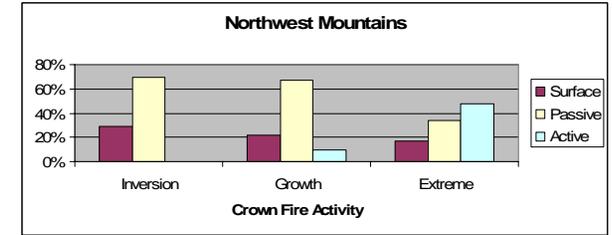
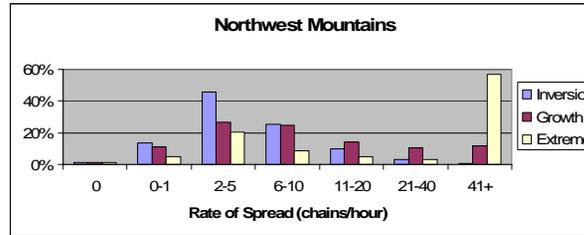
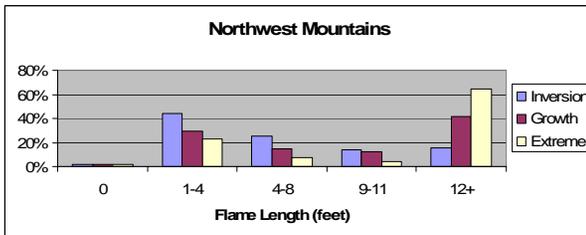
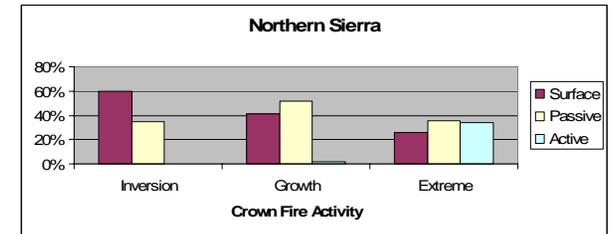
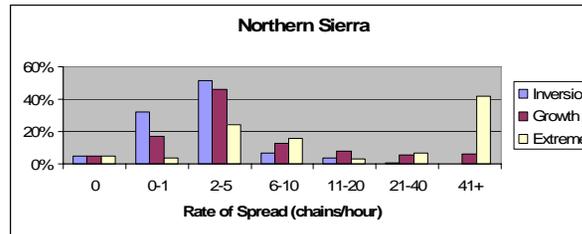
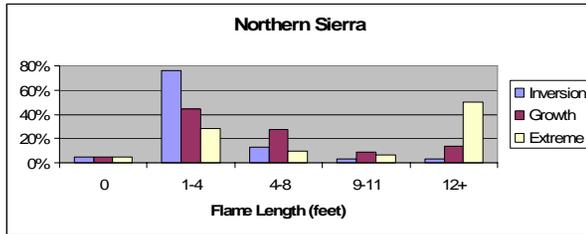
A comparison of fire characteristics for each of the burning conditions indicates the following:

- Flame lengths tend to remain 4 feet or less over 70 – 80 percent of the area during inversion type conditions.
- Rate of spread remains less than 10 chains per hour in a large percentage of the area except during extreme type conditions.
- Crown fire activity largely remains in the surface or passive category except during extreme type conditions.

Comparisons of PSAs for the modeled fire characteristics indicate:

- The Northern Mountain PSA has a larger percentage of the area with flame lengths greater than 12 feet.
- There is little difference between PSAs in the distribution of rate of spread.
- There is a higher percentage of active crown potential in the Northwestern Mountain PSA.

Figure 2



## Outlook by Time Period – Weather, Fire Danger, and Fire Behavior

### 7 Day Outlook

#### Weather

- High pressure will build overhead late this weekend and produce very dry and hot weather through midweek.
- During this time overnight winds will be north/northeasterly from the west slopes of the Sierra to the coastal mountains with locally gusty conditions, which will limit RH recovery, but this pattern will not be widespread. Instead, these winds and their drying effect will occur in the usual wind-prone areas.
- There is a potential for a monsoonal surge of moisture moving over the interior later in the period.

#### Fire Danger

- Live fuels are currently acting as a heat sink at high elevations, while at lower elevations herbaceous are cured.
- Below normal amount of new growth, which acts to retard fire behavior, is resulting in a greater contribution to fire spread due to the change in live to dead fuel ratios.
- Both live and dead fuels are ahead of their typical dryness time frames by one to two months, and in some cases fuels are record-setting dry. Departure from Average Greenness map below graphically illustrates the drier than normal condition of the fuels throughout most of the northern California area indicated by the yellow and brown colors.

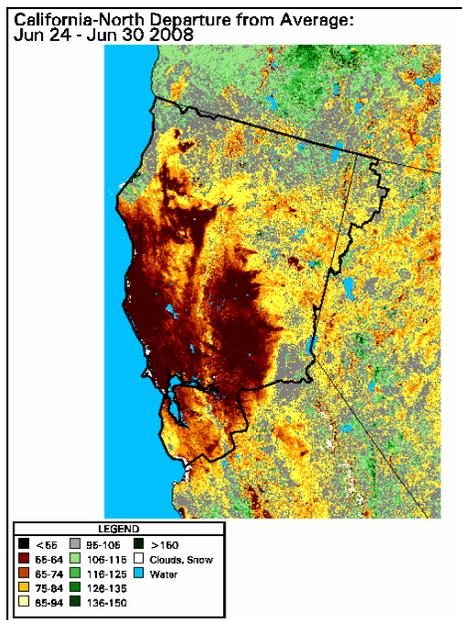


Figure 3. Mid Coast, Sacramento Valley/Foothills, and Northwestern Mountains PSAs are most significantly departed from normal greenness.

- ERCs for all northern California Predictive Service Areas (PSA) are still on an upward trend. Energy Release Component (ERC) values are ranging from above normal to record highs for the date, with most PSAs at or approaching the 90<sup>th</sup> percentile for the season. The North Sierra PSA set new highs for ERC in May and is now at the

maximum for this date, approaching the 97<sup>th</sup> percentile for the season. The biggest anomalies are at low to mid elevations.

[http://gacc.nifc.gov/oncc/predictive/fuels\\_fire-danger/psac/erc/index.htm](http://gacc.nifc.gov/oncc/predictive/fuels_fire-danger/psac/erc/index.htm)

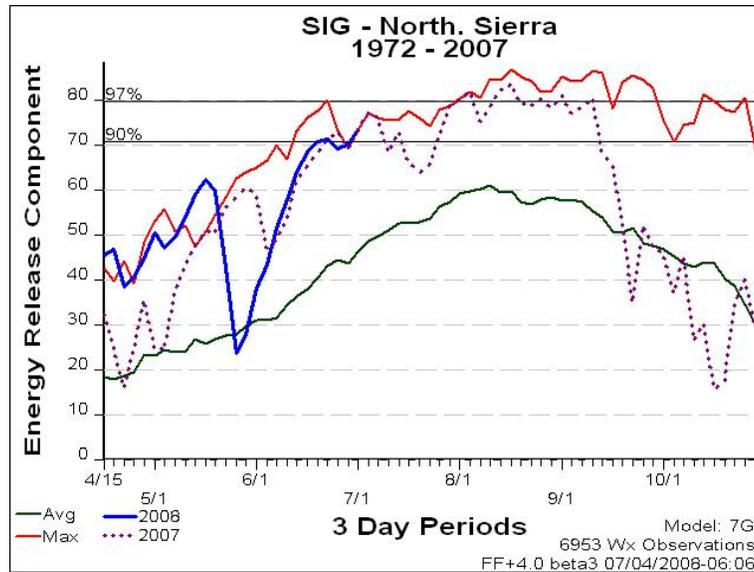


Figure 4. Seasonal ERC graph for North Sierra PSA shows maximum and average values compared to 2007 and 2008 to date.

### Fire Behavior

- The current 7-Day Significant Fire Potential chart (July 4) shows at least a 20% probability for large fire growth next week due to hot and dry conditions over all northern California PSAs except the North Coast.
- Live fuels are currently acting as a heat sink at higher elevations.
- Herbaceous fuels at lower elevations are cured, resulting in rapid rates of spread.
- 1000-hour fuels are contributing to fire spread in all PSAs
- Low to mid- elevations currently have highest probabilities of significant fire spread over 7 days, especially in the southern part of Mid Coast PSA (FSPPro 7-day runs).
- Short-range spotting is expected when inversion lifts.
- The North Sierra and Sacramento Valley/Foothills PSAs have a high potential for large fire growth and intense fire due to record high ERC and low fuel moistures.

### 30 Day Outlook

#### Weather

- Little or no precipitation is forecasted for July.
- Temperatures for July are expected to be near normal to slightly above normal. July averages six days in which temperatures in the Redding area are 100 degrees.
- Northeast wind events are not typical between July 4 and Labor Day.
- There are nine to twelve days of possible thunderstorm events (mostly dry) expected for the month of July; more than last year.
- Smoke may affect the weather.

## **Fire Danger**

- Expect currently green brush and forbs at higher elevations to cure early and contribute to fire activity by mid-July.
- ERC is rising and is expected to continue upward.
- 1000-hr fuels are drying and are expected to continue this trend.
- Live woody fuels will fall to critical moisture values earlier in the year than normal.

## **Fire Behavior**

- Expect increased fire intensities and spread rates in all PSAs as ERC rises.
- There is an 80 -100% probability that fires in close proximity would grow together without suppression actions (FSPro 30-day runs).
- Fires close to the west side of the valley are more likely to have fire spread influenced by localized wind events.
- Smoky conditions can cause cooler temperatures, moderating fire behavior. However limited visibility may also obscure hot spots

## **Seasonal Outlook**

### **Weather**

- The Drought Monitor forecast shows the drought persisting or worsening over the season.
- Extended-range forecasts show little rainfall across California and the state is unlikely to experience significant improvement during the ongoing dry season.
- Local, terrain driven winds typically predominate during August with a reduced potential for strong pressure gradient winds.
- August is typically as warm or warmer than the month of July.
- The potential for wind events associated with frontal passages increases later in the season.
- The effects of smoke may have more of an effect on the weather as the season progresses.
- The Climate Prediction Center (CPC) outlook shows some probability of below normal temperatures for coastal areas from August through October and above normal temperatures for the North Sierra PSA.
- The CPC outlook shows some probability of below normal precipitation over most of northern California.

### **Fire Danger**

- On average throughout northern California, ERC peaks by mid-August then starts trending downward.
- Historic maximum ERC values in all PSAs have exceeded the 97<sup>th</sup> percentile as late as mid-October.
- Shorter day length and diminishing sun angle results in cooler temperature and higher humidity, which should begin to lower the potential for large fire growth in September and October.
- Analysis of fire and weather records over the past 20 years for each PSA using Fire Family Plus (ver. 3.0.5) indicates that few large fires (>300 acres) occur below the 70<sup>th</sup> percentile ERC, especially toward the end of the fire season. ERC was used as the criteria for season-ending events in the table below.

- Using precipitation events for season-end criteria yields later dates for 80 and 90% probability in the Northwestern Mountains (Cecilville and Orleans data)

Table 3. Probability of season end using ERC falling below 70<sup>th</sup> percentile with no recovery.

Predictive Service Area	80% probability	90% probability
Mid Coast to Mendocino	Oct. 24	Nov. 1
Northwestern Mountains - ERC	Oct. 22	Nov. 1
Northwestern Mountains - 2.0 " precip	Nov.13	Nov. 17
Sacramento Valley/Foothills	Oct. 28	Nov. 4
Northeast California	Oct. 20	Oct. 27
Northern Sierra	Nov. 3	Nov. 9

### Fire Behavior

- The Northern California Seasonal Outlook projects above normal potential for large fires over much of the geographic area between July and October due to record low precipitation to date and early drying of live fuels.

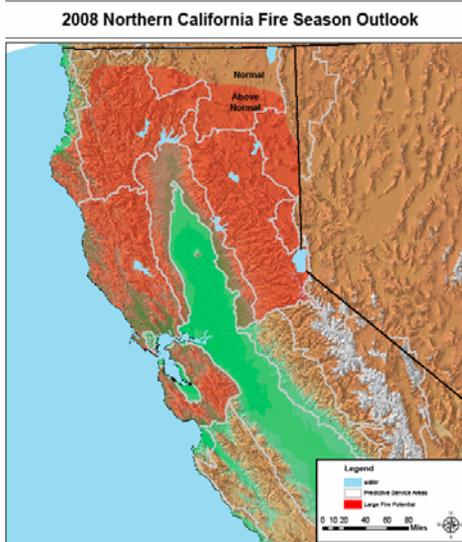


Figure 5. Above normal large fire potential indicated by red areas

- Foehn wind events in September and October will increase the potential for large, wind-driven fires in the lower elevation PSAs.
- Continuing drought conditions will allow for high probability of ignition, increased fire intensity, and significant crowning and spotting potential.

### General Management Implications

- Due to the early establishment of large fires in numerous locations across northern California, the opportunity for even larger growth is compounded.
- Effectiveness of fire suppression resources will be hampered by smoke concentrations at both the local and larger area, especially in the Klamath and Yolla Bolly Mountains, and

- the Trinity Alps. This may limit aerial support and impact situational awareness due to reduced visibility, as well as increase the potential for fatigue and decision-making errors.
- Fuel conditions will continue to contribute to high probability of ignition and large fire growth potential in the low and mid elevations. The unusually early drying of fuels at the higher elevations will soon have the same effect there.
  - Increased fire intensities, rapid spread rates, and high spotting potential in extremely dry fuels will reduce the probability of successful initial suppression actions.
  - The potential for large fire growth is expected to continue or increase for at least the next two to three months as drought conditions persist or worsen.
  - Numerous potentially long-duration fires are currently positioned in areas that have historically experienced rapid fire growth events triggered by conditions which developed later in the summer or fall.

## ***Links and References***

### **Northern California Daily Weather Outlook**

<http://gacc.nifc.gov/oncc/predictive/weather/DailyOutlook.html>

### **7-day Significant Fire Potential**

[http://gacc.nifc.gov/oncc/predictive/weather/Fire\\_Potential.html](http://gacc.nifc.gov/oncc/predictive/weather/Fire_Potential.html)

### **Monthly Outlooks**

[http://gacc.nifc.gov/oncc/predictive/outlooks/monthly\\_outlook.pdf](http://gacc.nifc.gov/oncc/predictive/outlooks/monthly_outlook.pdf)

### **Seasonal Assessments**

[http://gacc.nifc.gov/oncc/predictive/outlooks/seasonal\\_outlook.pdf](http://gacc.nifc.gov/oncc/predictive/outlooks/seasonal_outlook.pdf)

### **Northern CA Smoke Transport and Stability Outlook**

[http://gacc.nifc.gov/oncc/predictive/weather/daily\\_smoke/Smoke.html](http://gacc.nifc.gov/oncc/predictive/weather/daily_smoke/Smoke.html)

### **Energy Release Component by Predictive Service Areas**

[http://gacc.nifc.gov/oncc/predictive/fuels\\_fire-danger/psac/erc/index.htm](http://gacc.nifc.gov/oncc/predictive/fuels_fire-danger/psac/erc/index.htm)

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